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Validity and Practicality of Ongoing Assessment using STEM Approach Based Multiple Representation and Integrated with 21st Learning

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Abstract: The purpose of this research is to use science, technology, engineering and mathematics (STEM) methods for effective and practical ongoing assessment, which is based on multiple representations and combined with the 21st learning magnetic field ability of Indonesian Lampung Bandar Lampung High School students. This ongoing assessment development adapted the Borg and Gall development model, which was grouped into four stages, such us: preliminary research stage, planning and development stage, the field test stage, and the dissemination stage. The research sample was 30 grade XI high school students who were taken randomly. Data collection techniques can use questionnaires, observation sheets, and tests. The data analysis technique used a qualitative approach with descriptive analysis techniques. The results showed that the ongoing assessment with stem approach multiple representations based integrated to 21st-century learning was stated: (1) valid, covering an average valid content of 83.38% and average construct validity of 78.33% (2) practical, including readability, easy to apply in learning and got positive responses from students, stated practical with an average percentage of 83.40%.

Keywords: Multiple Representations, on-Going Assessment, and STEM Approach

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INTRODUCTION

The fact is that 21st century skills have four characteristics. The four characteristics are critical thinking and problem solving skills, communication, creativity and innovation, and collaboration. However, high order thinking and problem solving skills of high school students are still low (Prasetyani, Hartono, & Susanti, E, 2016). The low ability of high school students in higher order thinking (HOTS) and problem solving skills stems from the lack of training in questions oriented to HOTS and problem solving (Laili, Aini, & Christanti, 2020 and Mustofaa & Rusdianab, 2016). HOTS and problem solving skills are intended so that students can expand their knowledge and abilities to solve problems in an increasingly complex real world. In the context of education at that time, a learning approach that integrates interdisciplinary learning was introduced to train students to gain mastery of the required competencies, namely the STEM learning approach.

HOTS is the ability of students to think at higher level, not just memorize or say something to another person exactly like something delivered to us. According to (Heong, 2011) HOTS is a broad use of the mind to find new challenges. HOTS can stimulate students to be able to apply new information or new knowledge and be able to analyze and manipulate this information for problem solving purposes based on the situation. *HOTS* are divided into several aspects such as: decision making, problem solving, critical thinking and creative thinking (Espasa, 2000). According to (Widana, 2017) HOTS include the ability to solve problems, critical thinking skills, creative thinking, argumentation skills, and decision-making skill. HOTS is an important ability in the modern world, so it must be owned by all students. The importance of HOTS in learning physics is to provide direct experience to develop competencies in order to explore and understand the natural surroundings scientifically.

In addition to be required to have HOTS, students must also be able to have problem solving skills. Problem solving is the ability to formulate new answers that are more than just the simple application of previously learned rules to achieve a goal (Woolfolk, 2009). Problem solving is the ability to develop prior learning principles, procedures, prior knowledge, and specific strategies for solving problems. Defining goals, analyzing situations, planning solutions, implementing problem solving, and evaluating what has been done are the stages students use in solving problems (Crebert, 2011). According to (Woolfolk, 2009) problem solving ability is the ability of students to solve problems with stages, such as recognizing and categorizing various types of questions, representing problems concretely in the form of images, symbols or verbal forms, and selecting relevant information. The linkage between problem-solving skills with HOTS is that HOTS aspects divided into four groups: decision-making, problem solving, critical thinking and creative thinking.

The importance of HOTS and problem-solving in learning in human life who has entered the 21st century. In the 21st century, science and technology is developing very rapidly. The development of science and technology really helps human life. A shift in the way of learning must be carried out to anticipate the needs of the 21st century. 21st century learning simply means learning that provides 21st century skills to students such as 4C which includes: 1) communication, 2) collaboration, 3) critical

thinking and problem solving, and 4) creative and innovative. The application of scientific approaches in 21st century learning is like HOTS, and literacy integration.

Higher-Order Thinking Skills (HOTS) which include the ability to analyze, evaluate, and create (Anderson, 2001). Higher order thinking skills in physics include the ability to analyze, evaluate, and create, which are indispensable for the advancement of advanced physics. One thing that can help to see the development of HOTS is the need for an assessment to measure HOTS.

One way that can help to improve skills in the 21st century such as 4C and HOTS is needed for assessments to measure HOTS of the students. One way to improve students' learning and thinking skills according to Permendikbud No.65 of 2013, namely by using an appropriate assessment system is an ongoing assessment. Permendikbud No.65 of 2013 explains that the process of closing activities in teaching learning must reflect to evaluate all learning activities and the results obtained are reviewed to find their benefits, then provide feedback on the learning process and results, and follow up in the form of assignments and plan learning next (Pemerintah Republik Indonesia, 2013).

Mastery of the material is shown by the ability to represent the material in various formats or presentations, these various ways of presenting are called plural representations. According to Rosengrant, Etkin, & Heuvelen (2007), the use of multiple representations can help students in practicing problem solving skills. Plural representations include words, symbols, spoken or written equations and pictures. Therefore, multiple representations need to be juxtaposed in the assessment instrument to measure higher order thinking skills and more effective problem solving.

Implementing the ongoing assessment needed to improve higher order thinking skills (HOTS) using ongoing assessment with STEM-based. Ongoing assessment STEM based is expected to play an important role in improving thinking skills HOTS and problem solving. According to (Laboy, 2010), STEM (Science, Technology, Engineering, and Mathematics) in learning is a learning program that combines two or more fields of science contained in STEM (Science, Technology, Engineering, and Mathematics). All activities in the program are STEM centered on involving students in defining and formulating a solution to authentic problems in the real world. Thus, there developed the Ongoing Assessment on STEM-based approach on multiple- integrated representation of 21st century learning to improve higher-order thinking skills and solving physics problems.

METHOD

Research Design

This study used a research and development design to adapt the Borg and Gall development model, which were grouped into four stages, such as: preliminary stage, planning and development stage, the field test stage, and the dissemination stage. The Preliminary Stage includes: initial research, study of research results, gathering information, such as curriculum analysis, and literature review. The planning and development phase includes: preparation of storyboards, compiling ongoing assessments, making lesson plans, validation of the ongoing assessments and other

learning tools by experts. The field test stage, such as the limited scale trial. Field tests were used to see the practicality of ongoing assessment in STEM-based learning with multiple representations of integrated learning in the 21st century.

Data Collection and Instrument

The instruments used in this study was a questionnaire that consists of a student needs analysis questionnaire and student responses to the use of ongoing assessment, validation sheets, observation sheets and ongoing assessment.

Data Analysis

The data analysis stage carried out are the validity test and the practicality test. Data analysis in this study in detail is represented in Table 1.

Table 1. Variables, Required Data, Instruments, and Data Analysis

Variables	Required Data	Instruments	Data Analysis
Validity	Content validation data results	Content validation sheet	Descriptive statistics, percentage technique
Practicality	Data on learning implementation, and student responses	Response Questionnaire	Descriptive statistics, percentage technique

RESULT AND DISCUSSION

Research result

Research and development results are grouped into 2, namely the validity of the *ongoing assessment* and the practicality of the *ongoing assessment.*

Validity of the Ongoing Assessment

Before being piloted on a limited scale, the prototypes and tools were validated by experts and practitioners. The results of the validation of 3 experts and 2 practitioners (high-school physics teachers) are presented in Table 2.

Table 2. Contents and constructs *validity of* ongoing assessment based on STEM oriented, integrated multi-representation 21st century learning.

Aspect	Average (%)	Description
Construction	78.33	Valid
Content	83.38	Highly Valid
Language	86.60	Highly Valid

Based on Table 2 the average content validity is 83.38 and the construct validity is 78.33 including the valid category. This means that the ongoing assessment of STEM-based on magnetic field that is oriented to multiple representations and integrated 21st century learning is theoretically valid.

Practicality of the Ongoing Assessment

The practicality of the ongoing assessment was determined based on the product implementation in learning and student responses to the ongoing assessment used in the study of magnetic field. The ongoing assessment implementation is measured through observational aspects, namely the implementation of ongoing assessment, social systems, and reaction principles. The results of the recapitulation of the Ongoing Assessment are shown in Table 3.

Table 3. Recapitulation of Learning Implementation Observation

Aspect	Rate	Information
Implementation of *Ongoing Assessment*	83.40%	Very High
Implementation of Social Systems	89.52%	Very High
Implementation of Reaction Principles	95.5%	Very High

Based on the data in Table 3 it is known that in general the implementation of learning using ongoing assessment is very high. Aspects that were observed in the implementation of learning included activities of ongoing assessment, social systems, and reaction principles.

The ongoing assessment for an average of 83.40% was in the good category, meaning that STEM-based multiple representation oriented and integrated 21st century learning was easily applied by teachers in learning magnetic field. Likewise, the student response to the use of ongoing assessment in learning, only 23% of students said that the ongoing assessment used in learning was the same as other assessments (mediocre). Student responses to ongoing assessment are shown in Table 4.

Table 4. Student responses to ongoing assessment

Types of assessment	**Student responses (%)**			
	Very Helpful (Positive)	**Helpful (Positive)**	**Mediocre (Negative)**	**Less (Negative)**
Ongoing Assessment	17.5%	54.7%	23%	4.8 %
Advantages of the model	1. Can assist in problem solving. 2. Easy to understand concept because it is presented in several ways. 3. Help to develop thinking skills			
Weaknesses of the model	1. The examples given are not many. 2. Sometimes confusing.			
Suggestions	1. Reproduce examples of questions. 2. Presented in simpler terms with easy to understand language.			

Discussion

Material validation consists of three validator experts. Validators validate several aspects including material structure, social, reaction principles, support systems and accompaniment impacts. The average content validity (content validity) 83.38% with very valid category. *Ongoing assessment* based on STEM multiple representations oriented and integrated 21st century learning is prepared in accordance with Permendikbud No.65 of 2013. Permendikbud No.65 of 2013 explains the process of closing activities on teaching learning, educators must reflect to evaluate all activities and learning outcomes which are then reviewed to find the benefits. According to (Andhini, 2020) states that one way of realizing learning is in accordance with Permendikbud No. 65 of 2013 is by using an appropriate assessment system, namely ongoing *assessment*.

Setiawan, Rosidin, & Suyatna (2019) that learning with continuous assessment can improve student's higher-order thinking skills. The results of Rosidin, Distrik, & Herlina, (2018) research also support the results of this study where the use of continuous assessment in learning can improve student's problem solving abilities. The implementation of continuous assessment, especially during the learning process, will be better if it is supported by techniques or learning models that are able to provide faster feedback during the learning process (Surahman, Maharta, & Abdurrahman, 2013).The ongoing *assessment* that was made contained science and technology literacy, the material in the ongoing assessment was presented following the STEM approach and each STEM step was explained by multiple representations.

The result of construct validation is averaged on 78.33%, therefore the development of ongoing *assessment* based on expert tests, the construct validity was declared valid. The three experts agreed that the *ongoing assessment* made was constructively valid. The Development *ongoing assessment* based on the value of the construct validity test was declared valid because it obtained an average value of ≥70% (Akdon, 2011). Ongoing assessment that has been developed is feasible from the construction aspect. Aspects of product construction are said to be feasible with indicators such as clear questions to convey the information to be assessed, questions do not have multiple meanings, and questions can be interpreted as facts.

This is in accordance with the material structure in the *ongoing assessment* supported by cognitive learning theory and constructivism, non-contradictory, interrelated between one sentence and another, allows social interaction, reaction principles, is supported by technology, and has accompanying effects, such as being able to motivate students in studying physics. *Ongoing assessment* based on multiple representation-oriented STEM meets the characteristics of teaching materials, such as theoretical rationale, learning objectives to be achieved, teacher behavior, and learning environment (Arends, 2012). *Ongoing assessment* is a process to prepare students so that they can give clear responses to determine the extent of students' understanding and aims to help improve student performance at subsequent meetings (Kumala, 2011). *Ongoing Assessment* based on multiple representation-oriented STEM also has 5 main elements as stated by (Joslin, 2010), such as: (1) Has learning steps (syntax), (2) social system, (3) reaction principle, (4) support system, and (5) Instructional and accompaniment impact.

The following shows the ongoing learning activities based on the integrated multi-representation-based assessment of the STEM approach, which is shown in Table 5.

Table 5. Learning activities Implementation of ongoing assessment based on multiple representations integrated with STEM approach

Step PBL	**Activity Description**		**Time Allocation**
	Teacher	**Student**	
Student orientation to problems	• The teacher describes a little about the phenomenon as follows: "There is iron sand leveled on a plane. If the iron sand is near a current carrying wire, it will look like Figure.  • The teacher asks questions such as: 1. What events occur in the system? 2. How does the system work? (the questions given can be answered using concepts or pictures as Multi-Representation questions) • Provide feedback on student answers about the concept of a magnetic field around a wire medan	• Students observe the phenomena given by the teacher: "There is iron sand leveled on a plane. If the iron sand is near a current carrying wire, it will look like Figure. • Students answer questions from the teacher. Answer: 1. There is a magnetic field around the wire so it can attract iron sand pasir 2. The magnetic system in the picture works using the principle of electromagnetic (electricity changes to magnetism) so that it creates magnetic properties around the wire which can attract and affect iron sand. (Answers can be pictures) **(Science as Concept (as STEM))**	

Ongoing assessments that have been theoretically valid are then carried out a practicality test which is carried out on 30 students of class XI which is carried out using blended learning. Practicality in terms of the implementation aspects of learning and student responses after learning using ongoing assessment. The implementation of learning was observed using an observation sheet from the aspects ongoing assessment which were illustrated by the activities of teachers and students during learning

activities. The process of implementing the practicality test is carried out during physics lesson hours. According to (Hobri, 2010) that, the practicality test of the device is seen from the positive response of students and the practicality of the device is seen in the management of learning carried out by the teacher. In product development research developed it is said to be practical if the experts and practitioners state that theoretically that the product can be applied in the field and the level of implementation of the model is categorized as "good." The term "good" still needs to be measured by indicators needed to determine the level of "practicality" of the model's implementation (Rochmad, 2012). Learning using ongoing assessment on the STEM approach received responses from students in the class in the good category, with an average percentage value of 83.40%. Student responses consist of aspects of student perceptions of student learning activities towards ongoing assessment on the STEM approach in improving higher-order thinking skills (HOTS) and problem solving in learning. Based on the description above, it shows that the instrument ongoing assessment in the STEM approach developed is practical. Based on the practicality tests that have been carried out, the ongoing assessment is stated to be very practical with an average value of 83.40% which is in the very high category, meaning that the ongoing assessment based on STEM towards multiple representation-oriented and integrated 21st century learning is easily applied by teachers in learning magnetic field.

In the learning process students are seen to be active in observing, collecting data, discussing, and asking questions both to teachers and to peers. Multiple representation-based learning makes students active in asking questions and discussions.

Representation is a very important role in the process of processing information about something. The physics learning process must be able to train students to convey a concept from the problems they use, and use language expressions, mathematics, tables, diagrams and simulations to find solutions (Monika, Abdurrahman, & Suana, 2014). The results of this study reinforce the findings of (Yanti, 2018), that multiple representation-based learning makes students actively ask, write, listen, and discuss with peers. According to (Wu, 2000) explained that the ability of representation is the ability to translate a representation from a concept into another form and the ability to produce or choose the right representation to make explanations, predictions, and justifications.

In the learning process students also feel helped by the *ongoing assessment*, such as the use of *ongoing assessments* will make students focus on understanding one indicator or sub material. This is because in learning using *ongoing assessment*, questions are given directly after students learn about the indicators or sub-material. If students answer incorrectly, students can immediately find out where the mistakes are and correct them according to the feedback (*feedback*) from the teacher. Feedback (*feedback*) motivates students to solve problems (Espasa, 2010), improving students' ability to assess themselves (Pokorny, 2010). This was shown through the student's response to the use of *ongoing assessment* in learning, there were 17.5% of students said they were very happy, 54.7% said they were happy to learn using an *ongoing assessment* based on STEM multiple representation-oriented, and only 23% said it was mediocre.

Based on the research results that have been obtained, there is a research update where the *ongoing assessment with stem approach multiple-representation-based*

integrated to 21st century learning so that it can improve higher-order thinking skills and physics problem solving skills and make students more practical in using *ongoing assessments* that can make it easier for students to access and studying the magnetic field.

CONCLUSION

Based on the results of research and development, ongoing assessment based on the STEM approach oriented to integrated multiple representation of 21st century learning is stated: valid and practical, so that it can improve higher order thinking skills and physics problem solving abilities. the implementation of ongoing assessment is able to make students focus on understanding the sub-materials because questions are given directly after students learn the sub-materials, so that if students answer incorrectly, then they will immediately be able to find out their mistakes and correct them according to feedback from the teacher.

During the learning process, it is necessary to condition research subjects and learning media used both online and offline so that the learning and research process can take place in a conducive and effective manner.

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